ANALOG DEVICES

EV-AD74412RSDZ User Guide
UG-1634

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Evaluating the AD74412R Quad-Channel, Software Configurable Input/Output

FEATURES

Fully featured evaluation board for the AD74412R
On-board 2.5 V ADR4525 reference
SPI
PC-based software for control

EVALUATION KIT CONTENTS

EV-AD74412RSDZ evaluation board

EQUIPMENT NEEDED

EVAL-SDP-CS1Z
Benchtop power supply and connector cables

DOCUMENTS NEEDED

AD74412R data sheet

SOFTWARE NEEDED

AD74412R evaluation software for control

GENERAL DESCRIPTION

The EV-AD74412RSDZ (see Figure 1) is a fully featured evaluation board that can be used to evaluate the features of the AD74412R. The AD74412R is a quad-channel, software configurable, input/output device. The device has functionality for analog output, analog input, digital input, and resistance temperature detector (RTD) measurements integrated into a single-chip solution with a serial peripheral interface (SPI)-compatible interface.

The EV-AD74412RSDZ can be controlled via a system demonstration platform (SDP). The EVAL-SDP-CS1Z (SDP-S) board allows the EV-AD74412RSDZ to be controlled via the USB port of a PC using the AD74412R evaluation software.

The EVAL- AD74412RSDZ requires an AVDD operating supply of 14 V to 26.4 V. When the EV-AD74412RSDZ is connected to the PC, the PC provides power to the SDP-S board.

For full details on the AD74412R, see the AD74412R data sheet, which must be consulted in conjunction with this user guide when using the EV-AD74412RSDZ.

EVALUATION BOARD PHOTOGRAPH

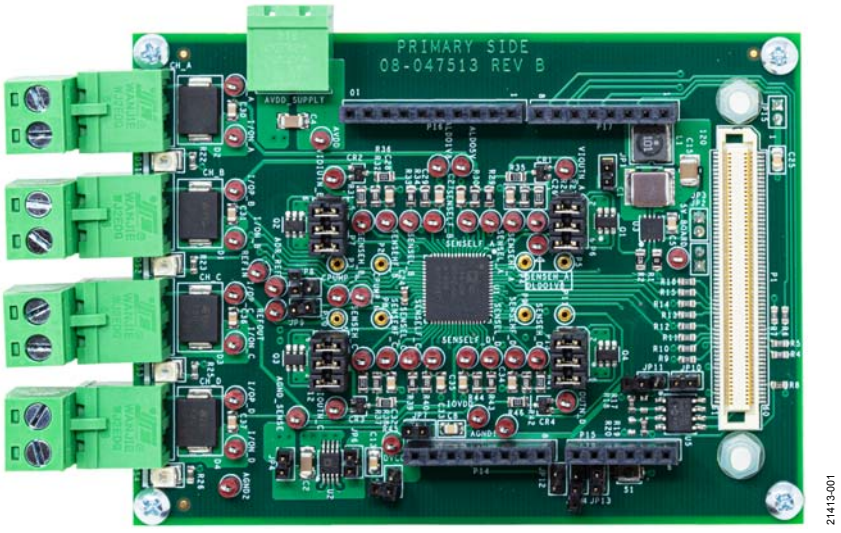

Figure 1.

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REVISION HISTORY

9/2019—Revision 0: Initial Version

EVALUATION BOARD HARDWARE

POWER SUPPLIES

The EV-AD74412RSDZ comes with a single power supply connector that provides power directly to the AVDD pin of the AD74412R. Set this supply as described in the AD74412R data sheet.

The AVDD supply on the EV-AD74412RSDZ powers an on-board regulator (ADP2360), which generates a 5 V supply to the EV-AD74412RSDZ (see Figure 2). The 5 V supply can be used for the following purposes:

- Power a 2.5 V external reference (ADR4525). The ADR4525 can be used as an alternative to the AD74412R on-chip reference.
- Power a 3.3 V regulator (ADP1720). The 3.3 V from the regulator powers the DVCC and IOVDD supplies of the AD74412R.

Figure 2 shows a simplified drawing of the power connections on the EV-AD74412RSDZ.

REFERENCE OPTIONS

By default, the EV-AD74412RSDZ is configured to use the AD74412R on-chip reference by shorting the REFOUT pin to the REFIN pin. There is also an external reference option available on the EV-AD74412RSDZ. The ADR4525 can be used instead of the internal reference. The appropriate jumpers must be connected if using the external reference. See Table 1 for the specific link options and functions.

OUTPUT CHANNELS

The four channels of the AD74412R are configured as described in the AD74412R data sheet. Figure 13 shows the schematic details for all four channels.

There are four channel screw terminal connectors on the EV-AD74412RSDZ. These terminals (CH_A, CH_B, CH_C, and CH_D) are used to connect the desired loads to the four channels of the AD74412R.

SPI COMMUNICATION

The SDP-S board handles the communication to the EV-AD74412RSDZ via the PC. By default, the SDP-S board controls the SPI communication, controls the $\overline{\text{RESET}}$ pin (driven high) and $\overline{\text{LDAC}}$ pin (driven low), and monitors the $\overline{\text{ALERT}}$ pin, $\overline{\text{ADC\_RDY}}$ pin, and the GPO_x pins of the AD74412R.

A reset button (S1) is also available on the EV-AD74412RSDZ.

The EV-AD74412RSDZ supports the use of an Arduino® board (such as the EVAL-ADICUP3029) when connected to the headers provided. See Table 1 for the necessary links to the Arduino header.

TEST POINTS

Multiple test points are available on the EV-AD74412RSDZ. Debug access is available for all pins on the AD74412R and on the four channel screw terminals. The test points are located adjacent to the relevant pins on the AD74412R.

LINK CONFIGURATION OPTIONS

The JPx and Px jumpers must be set properly for operation of the EV-AD74412RSDZ before using the EV-AD74412RSDZ. The functions and default states of these options are listed in Table 1.

Before applying power and signals to the EV-AD74412RSDZ, ensure that all links are set to the default positions, as defined in Table 1.

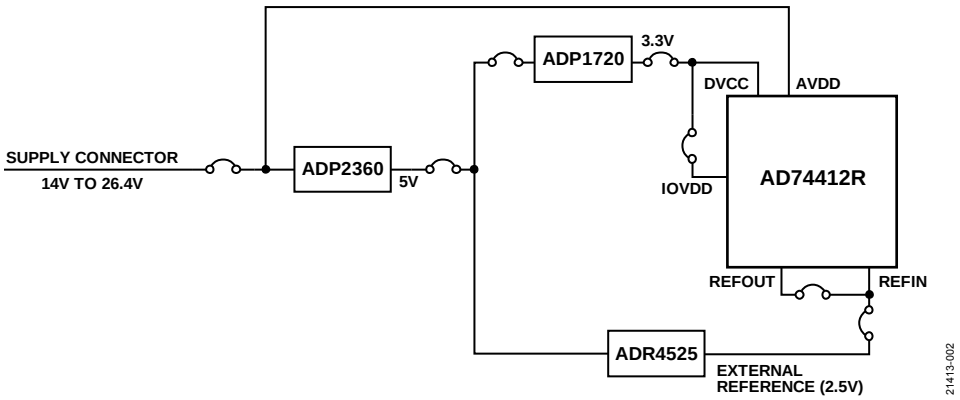

Figure 2. EV-AD74412RSDZ Simplified Power Diagram

Table 1. EV-AD74412RSDZSDZ Link Option Functions

Link	Function	Default Position
JP1	When inserted, the AVDD supply is used to power the ADP2360.	Inserted
JP2	When inserted, 5 V is supplied by the Arduino connector. When not inserted, JP3 can be used to provide the 5 V supply instead.	Not inserted
JP3	When inserted, 5 V is supplied by the ADP2360. When not inserted, JP2 can be used to provide the 5 V supply instead.	Inserted
JP4	When inserted, 5 V is used to power the ADP1720. When not inserted, no power is provided to the ADP1720.	Inserted
JP5	When inserted, the DVCC voltage is supplied by the Arduino connector. When not inserted, JP6 can be used to provide the DVCC supply instead.	Not inserted
JP6	When inserted, the DVCC voltage is supplied by the ADP1720. When not inserted, the DVCC supply can be supplied by the Arduino connector instead.	Inserted
JP7	When inserted the IOVDD voltage is connected to the DVCC voltage. When not inserted, no power is applied to the IOVDD pin.	Inserted
JP8	When inserted, the REFIN pin is tied to the output of the ADR4525.	Not inserted
JP9	When inserted, the REFIN pin is tied to the REFOUT pin (the internal reference of the AD74412R).	Inserted
JP10	When inserted, 3.3 V is provided by the SDP-S board. When not inserted, JP11 can be used to provide the 3.3 V supply instead.	Inserted
JP11	When inserted, 3.3 V is provided by the Arduino connector. When not inserted, JP10 can be used to provide the 3.3 V supply instead.	Not inserted
JP12	When inserted, the AD74412R reset can be triggered by the Arduino reset function.	Not inserted
JP13	When inserted, the AD74412R reset can be provided by the reset button on the EV-AD74412RSDZ.	Inserted
JP14	When inserted, the AD74412R reset can be triggered by an Arduino general-purpose input/output (GPIO).	Not inserted
JP15	When inserted, the 5 V supply can be used to supply the SDP-S board.	Not inserted
P6	Can be used to connect or to bypass the optional P-channel field effect transistor (PFET) for low resistive loads on Channel A of the AD74412R. Can be used to connect the AD74412R to the external screw terminal via the external PFET by connecting Pin 1 to Pin 2, Pin 3 to Pin 4, and Pin 5 to Pin 6. Can be used to bypass the external PFET by connecting Pin 1 and Pin 3.	PFET connected
P7	Can be used to connect or bypass the optional PFET for low resistive loads on Channel B of the AD74412R. Can be used to connect the AD74412R to the external screw terminal via the external PFET by connecting Pin 1 to Pin 2, Pin 3 to Pin 4, and Pin 5 to Pin 6. Can be used to bypass the external PFET by connecting Pin 1 and Pin 3.	PFET connected
P8	Can be used to connect or to bypass the optional PFET for low resistive loads on Channel C of the AD74412R. Can be used to connect the AD74412R to the external screw terminal via the external PFET by connecting Pin 1 to Pin 2, Pin 3 to Pin 4, and Pin 5 to Pin 6. Can be used to bypass the external PFET by connecting Pin 1 and Pin 3.	PFET connected
P9	Can be used to connect or to bypass the optional PFET for low resistive loads on Channel D of the AD74412R. Can be used to connect the AD74412R to the external screw terminal via the external PFET by connecting Pin 1 to Pin 2, Pin 3 to Pin 4, and Pin 5 to Pin 6. Can be used to bypass the external PFET by connecting Pin 1 and Pin 3.	PFET connected

SOFTWARE QUICK START PROCEDURES

ACCESSING THE AD74412R EVALUATION SOFTWARE GRAPHICAL USER INTERFACE (GUI)

The AD74412R evaluation software is used to communicate with the EV-AD74412RSDZ. To download the software executable, go to www.analog.com/AD74412R.

CONFIGURING THE BOARD

To set up the EV-AD74412RSDZ, take the following steps:

1. Connect a USB cable to the PC and then to the SDP-S board.
2. Connect the SDP-S board to the EV-AD74412RSDZ. The PC recognizes the EV-AD74412RSDZ.
3. Power up the EV-AD74412RSDZ with the relevant power supplies.
4. If not opened already, open the AD74412R evaluation software GUI. The GUI displays a green indicator to confirm that the AD74412R is connected (see Figure 3).
5. Click **Start** to begin configuration.

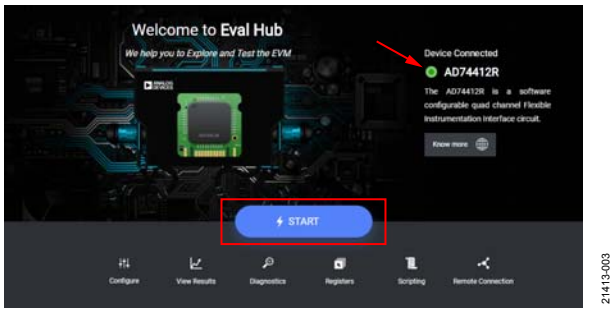

Figure 3. AD74412R Evaluation Software Start Page

USING THE SOFTWARE FOR EVALUATION

Configure Tab

The **Configure** tab is used to configure the four channels of the AD74412R. Each channel can be configured as described in the AD74412R data sheet. The dropdown menus are used to configure the required use case (see Figure 4).

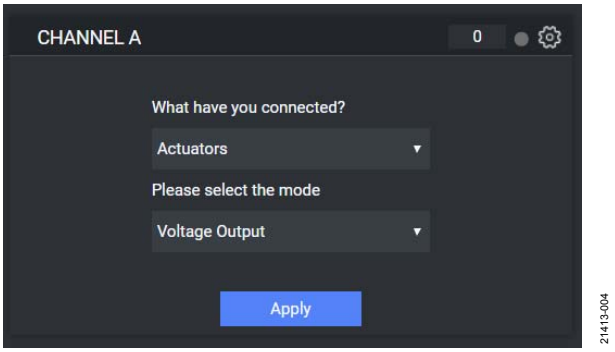

Figure 4. Channel Use Case View

When the use case is selected, the associated advanced settings display (see Figure 5). The gear icon in the top right corner of the page allows the user to toggle between the main settings and the advanced settings.

Click **Apply** to update the device with the selected settings.

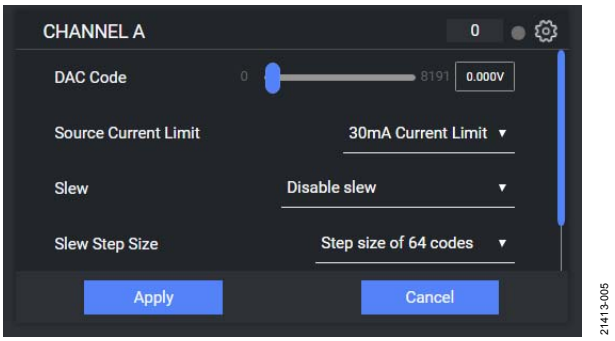

Figure 5. Channel Use Case Advanced Settings

View Results Tab

When the channel configuration is applied, click the **View Results** tab to see the channel monitor. Results from each channel are shown in a separate graph (see Figure 6).

Diagnostics Tab

In the **Diagnostics** tab, click the test points to enable measurements of the required diagnostics. Up to four diagnostics can be enabled at once (see Figure 7).

*Figure 6. **View Results** Tab*

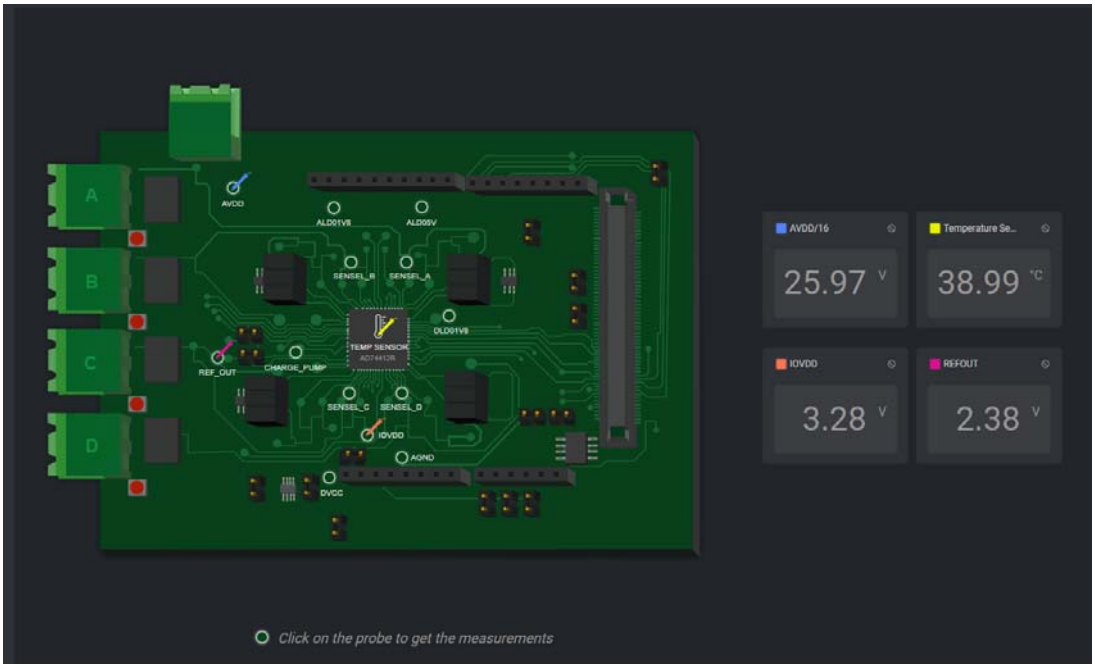

*Figure 7. **Diagnostics** Tab*

Register Map

The register map can also be used to interface directly to the AD74412R.

Immediate mode allows register writes to execute as soon as the bit fields are changed.

In deferred mode, no register edits are applied to the AD74412R until the **Write Register** button is clicked. The **Read Register** button must also be clicked in deferred mode to manually read from the device (see Figure 9).

Any changes made on the register map are automatically reflected in the **Configure** tab. Click **Apply** in the **Configure** tab to display results in the **View Results** tab.

Scripting Tab

The scripting tool allows simple scripts to be programmed, executed, and saved. When a script is written in the left panel, click the Run icon (see Figure 8) to execute the writes to the AD74412R. The panel on the right side of the page displays the results from any readbacks executed in the script. Commands supported by this page are currently limited to write and read operations (see Figure 10). The scripting feature has autocomplete enabled by default and validates the written syntax. The user can save and load configurations.

Figure 8. Run Icon

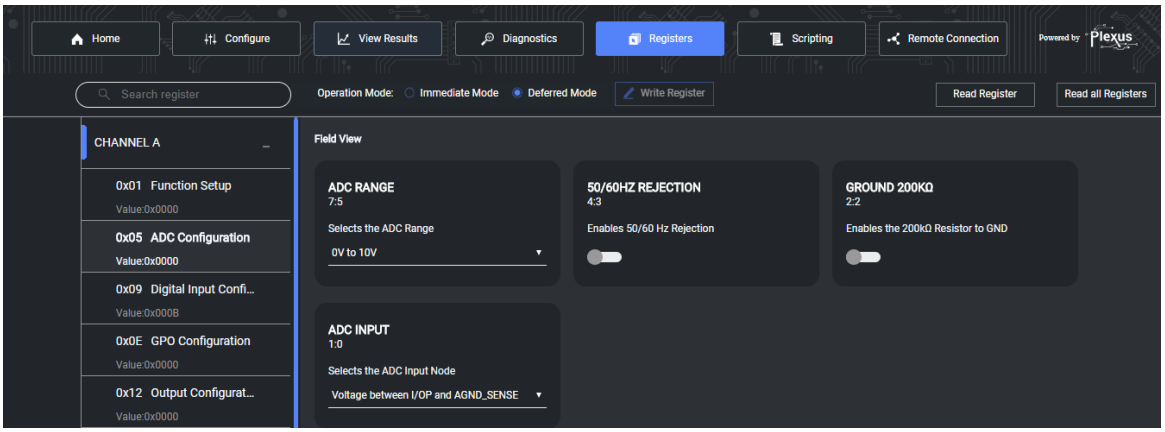

Figure 9. Register Map Display

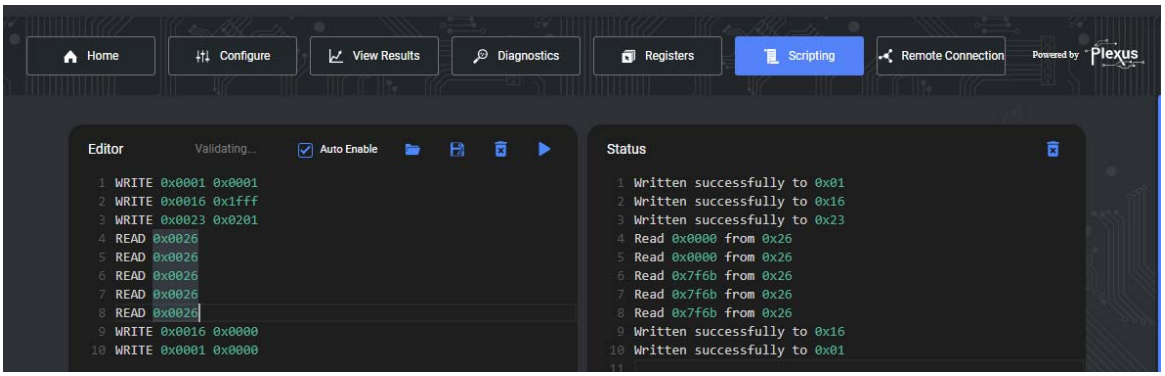

*Figure 10. **Scripting** Page Display*

EXAMPLE SEQUENCE

This section demonstrates how to configure the AD74412R for a selected function. The AD74412R data sheet must be consulted when programming the device.

Force Voltage Measure Current Example

This example is used to configure the AD74412R in voltage output mode, sourcing 11 V across the Channel A screw terminals. This example also measures the corresponding current through the R_{SENSE} resistor using the on-chip, analog-to-digital converter (ADC). The ADC measurement is completed using a conversion rate of 20 SPS with 50 Hz and 60 Hz rejection enabled. See Table 2 for the full list of commands.

A suitable load must be placed across the screw terminals. Refer to the AD74412R data sheet for more information.

To complete the register write steps shown in Table 2 using the AD74412R GUI, take the following steps:

1. In the **Configure** tab, use the dropdown menus to select **Actuators** and **Voltage Output** (see Figure 4).
2. In the **Advanced Settings** panel, set the **DAC Code** slider to 8191 (11 V).
3. Click **Apply**. This executes all writes required to configure the device and to enable ADC conversions in the default mode. This configuration allows the AD74412R to measure voltage across the R_{SENSE} resistor in the 0 V to 2.5 V range at a 20 SPS conversion rate.
4. Click the **View Results** tab to view the ADC results.

See Figure 10 for the corresponding script.

Table 2. Force Voltage Measure Current Instruction Set

Instruction	Instruction Description	W/R[1]	Register Name and Address	Data	Notes
1	Configure Channel A in voltage output mode	W	CH_FUNC_SETUPA, Address 0x01	0x0001	
2	Write full-scale code to DAC_A to generate 11 V	W	DAC_CODEA, Address 0x16	0x1FFFF	$\overline{\text{LDAC}}$ pin voltage = 0 V to allow outputs to be updated instantly.
3	Measure 11 V across Channel A screw terminals	N/A[2]	N/A[2]	N/A[2]	Use handheld meter to verify voltage.
4	Enable ADC to convert and measure current through R_{SENSE} resistor	W	ADC_CONV_CTRL, Address 0x23	0x0201	When the write in Instruction 1 is executed, the ADC automatically configures to measure voltage across the R_{SENSE} resistor in a 0 V to 2.5 V range.
5	Read ADC results	R	ADC_RESULTA, Address 0x26		
6	Calculate current through R_{SENSE} resistor using the equation available in the AD74412R data sheet	N/A[2]	N/A[2]	N/A[2]	$I_{RSENSE} = \frac{\left(V_{MIN} + \left(\left(\frac{AD\_CODE}{65535}\right) \times Voltage\ Range\right)\right)}{R_{SENSE}}$ where: I_{RSENSE} is the current through the R_{SENSE} resistor. V_{MIN} is −2.5 V, the minimum voltage is in the −2.5 V to 2.5 V range. The voltage range is 5 V.
7	Stop ADC conversions	W	ADC_CONV_CTRL, Address 0x23	0x0000	
8	Program DAC_A to zero scale	W	DAC_CODEA, Address 0x16	0x0000	Cleanup of DAC code and channel configuration is recommended before reprogramming the device.
9	Reset Channel A to high-Z mode	W	CH_FUNC_SETUPA, Address 0x01	0x0000	

[1] W is write and R is read.
[2] N/A is not applicable.

EVALUATION BOARD SCHEMATICS AND ARTWORK

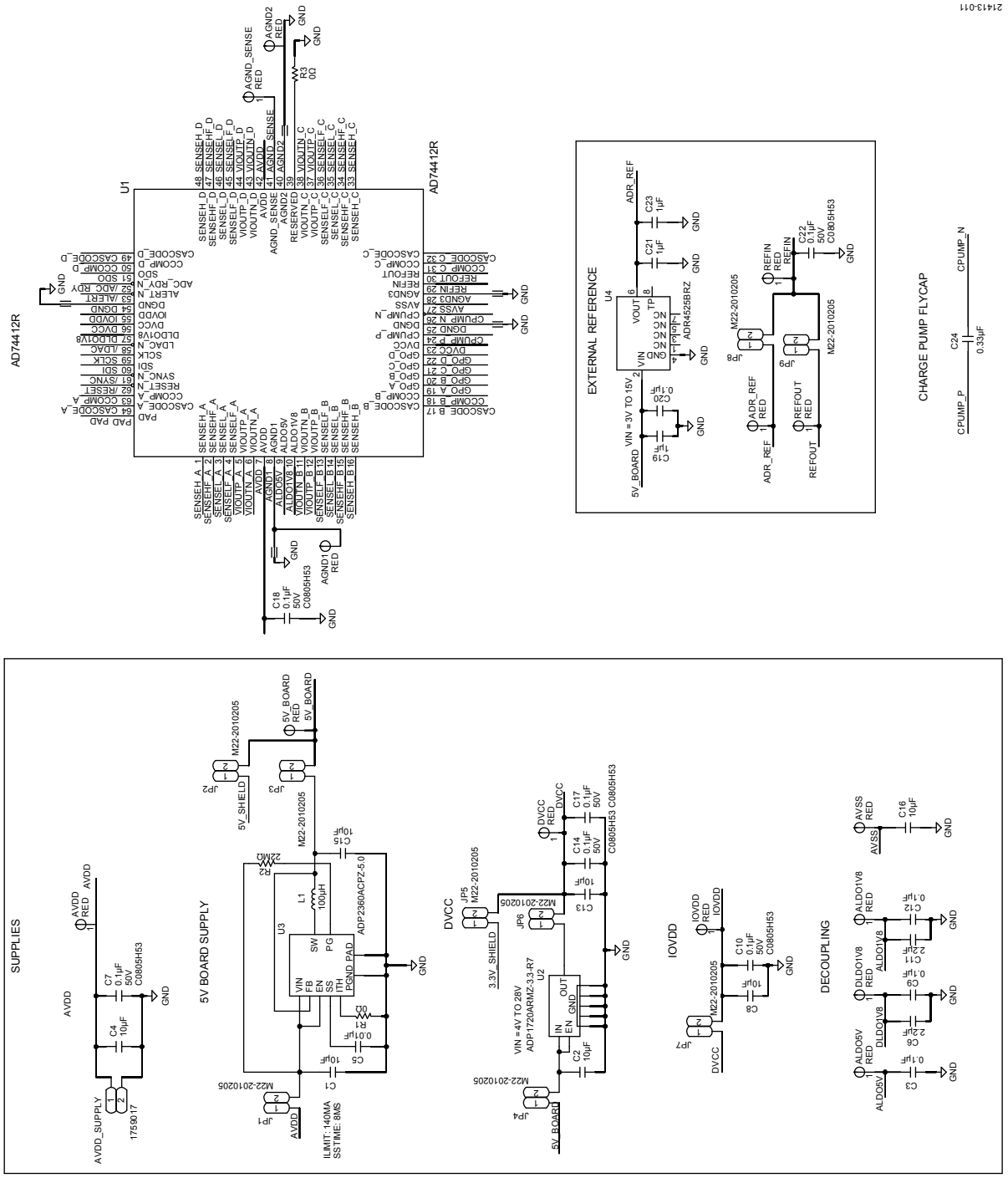

Figure 11. AD74412R, Supply and Reference Options

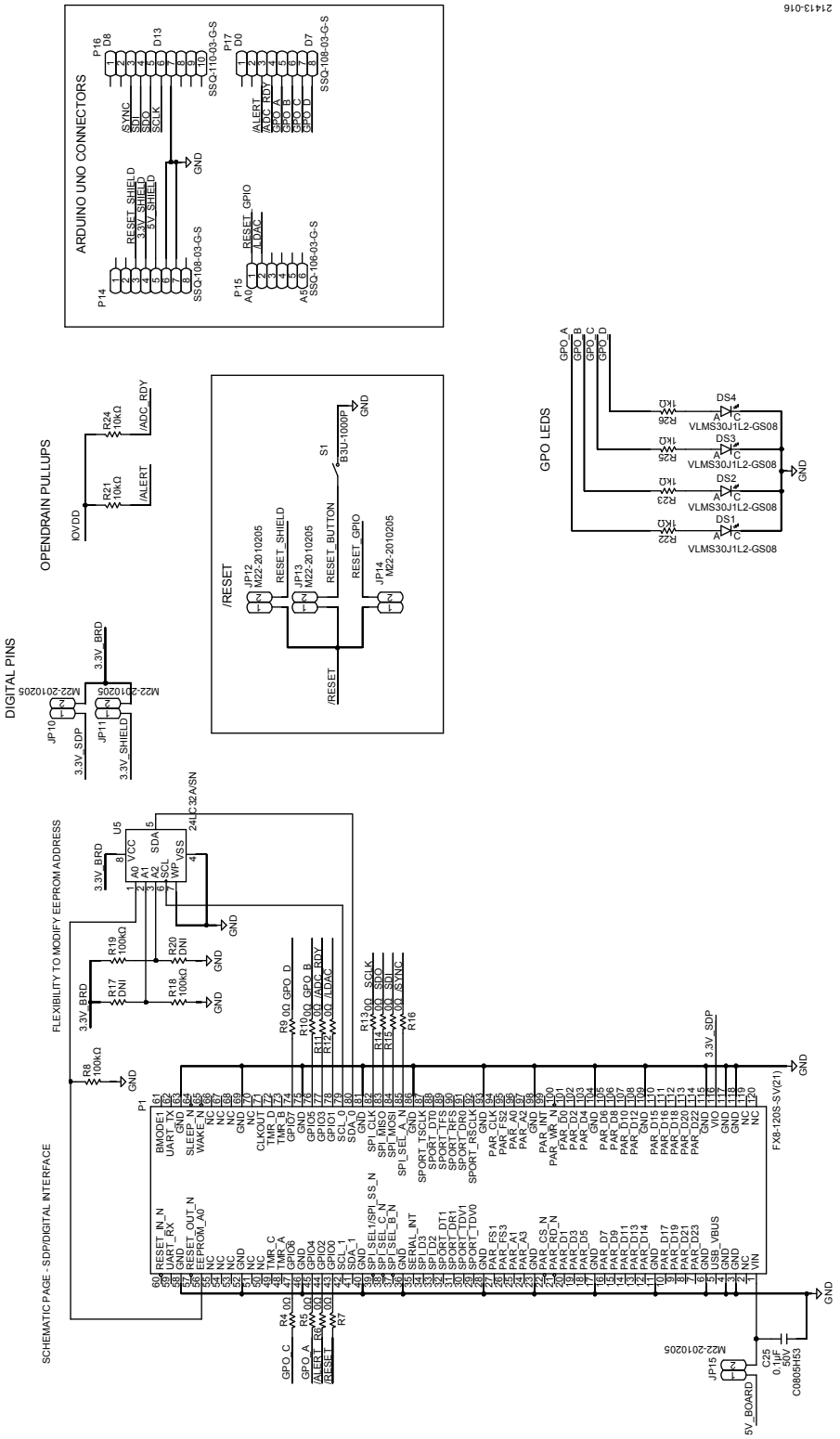

Figure 12. Digital Pins Including SDP-S Board and Arduino Board Connections

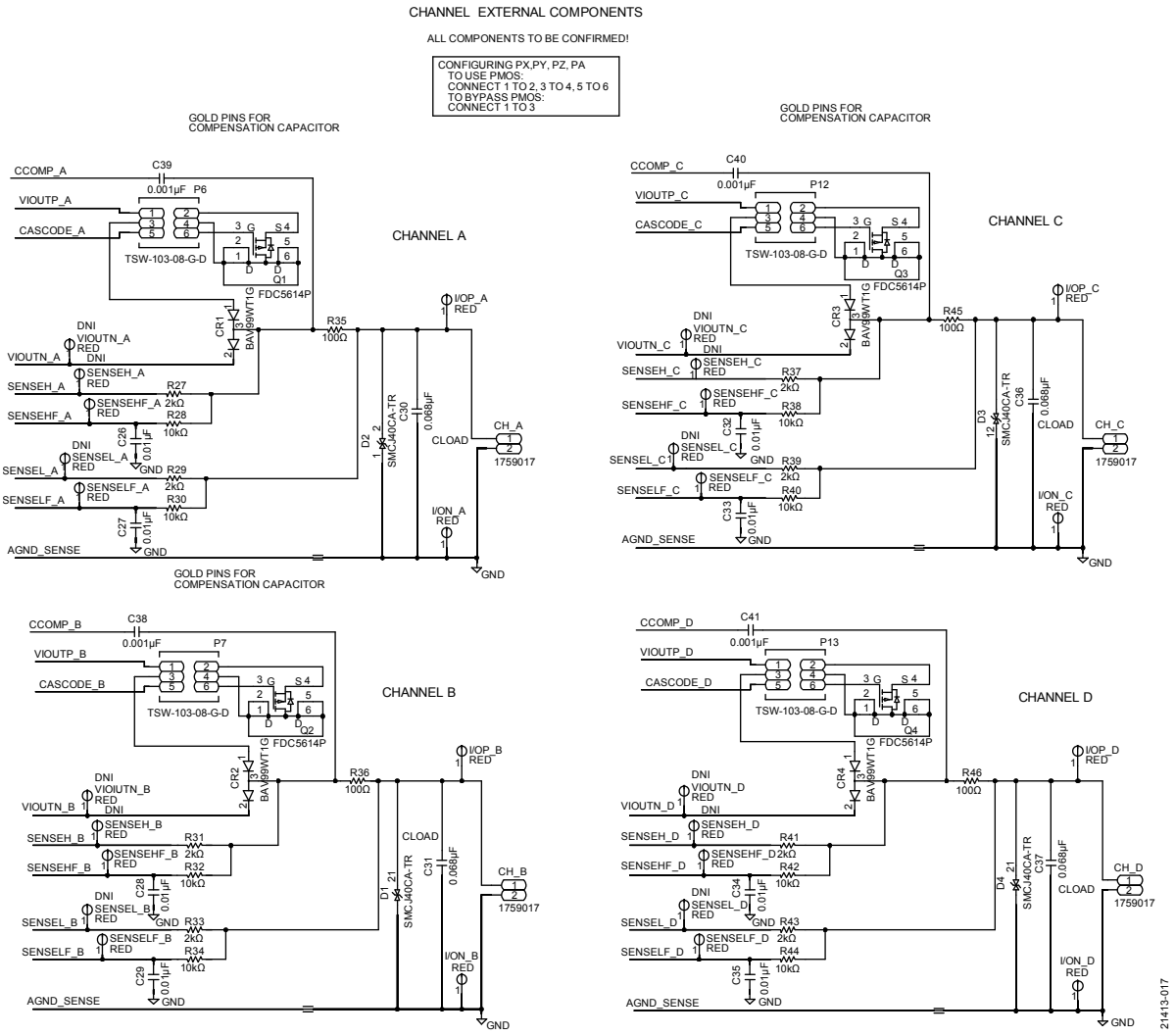

Figure 13. Channel Input/Output Circuitry Including Screw Terminals

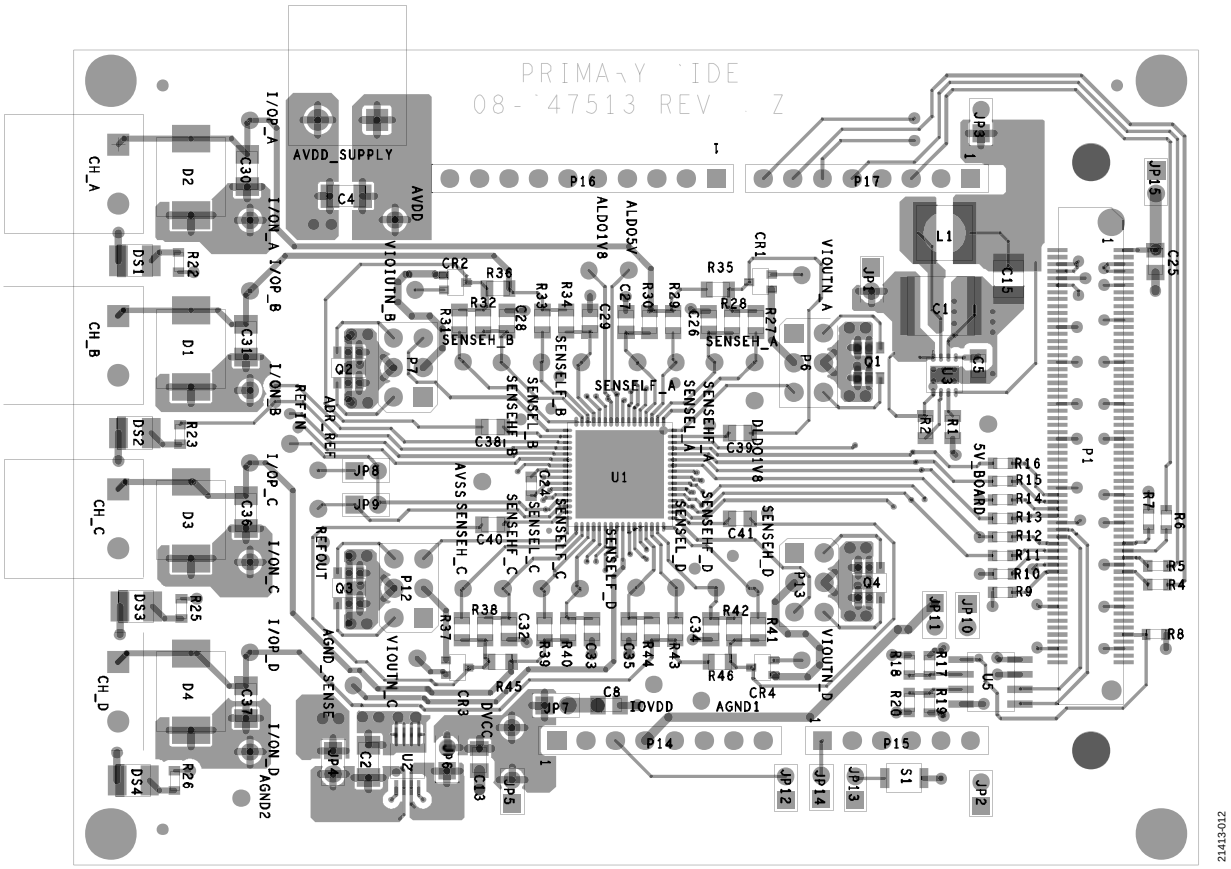

Figure 14. Layer 1, Top Layer

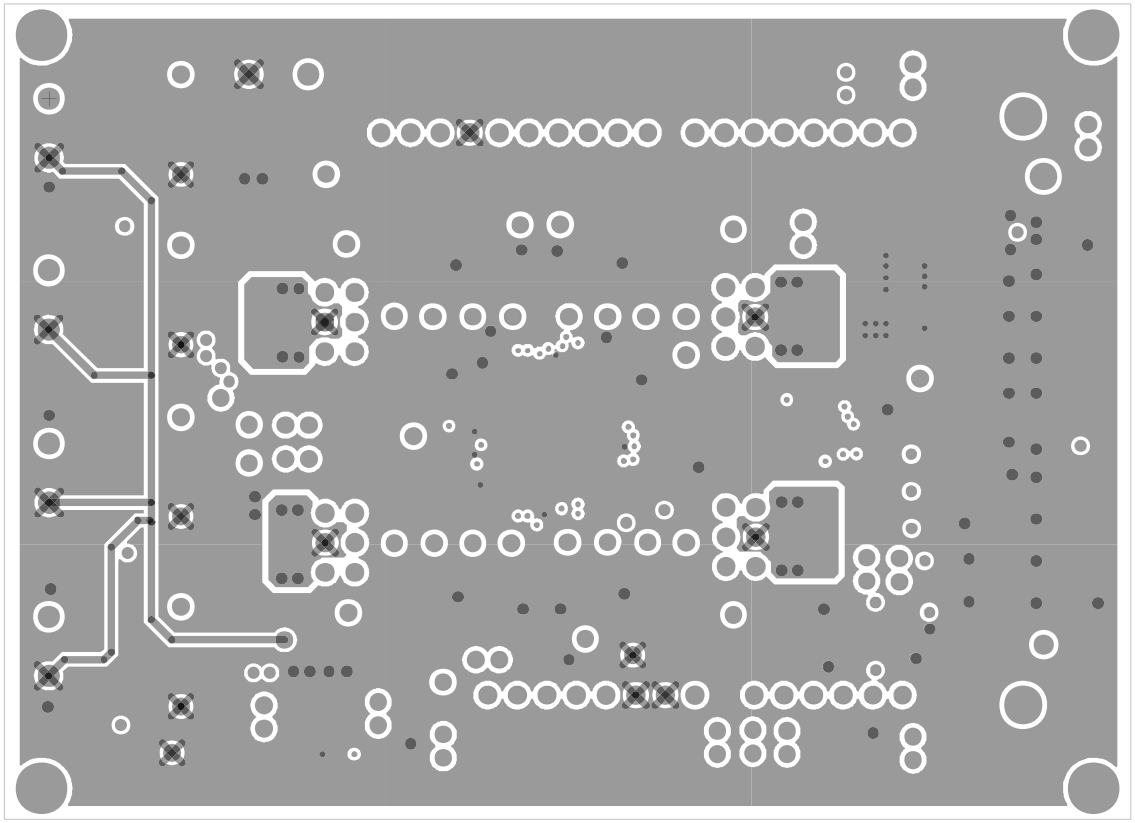

Figure 15. Layer 2, Ground Layer

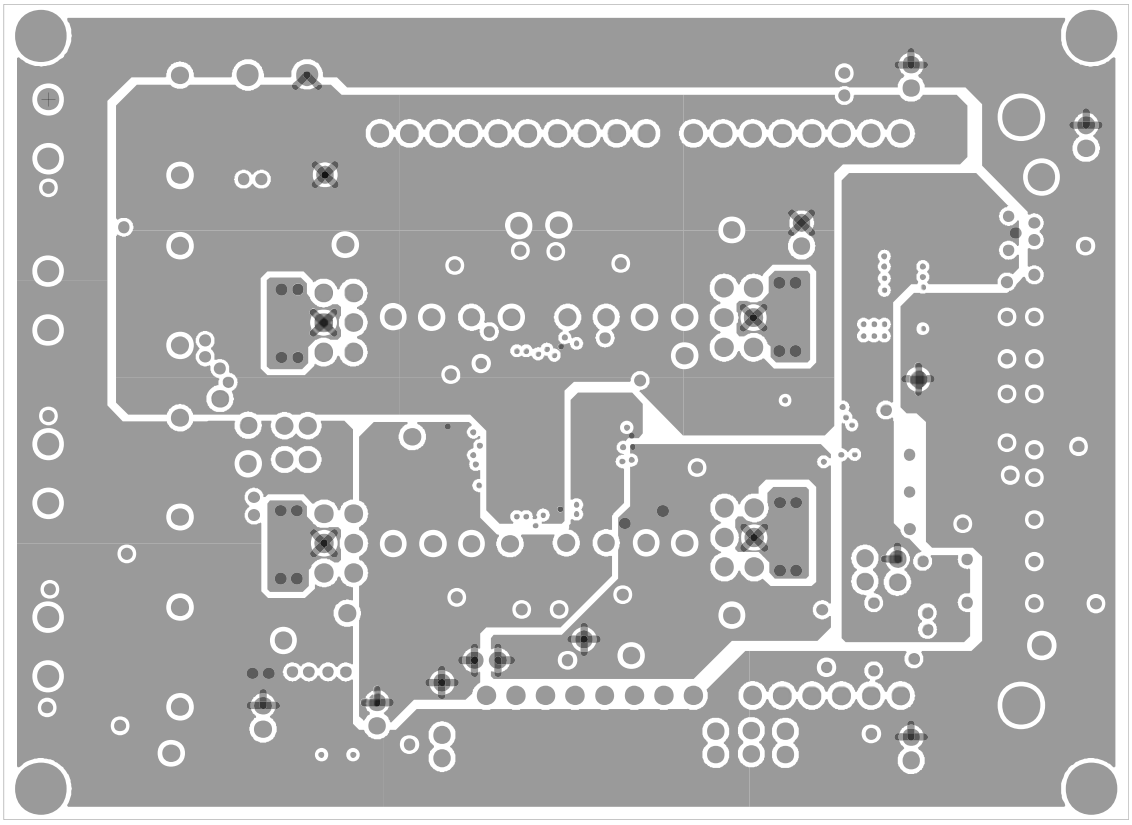

Figure 16. Layer 3, Power Layer

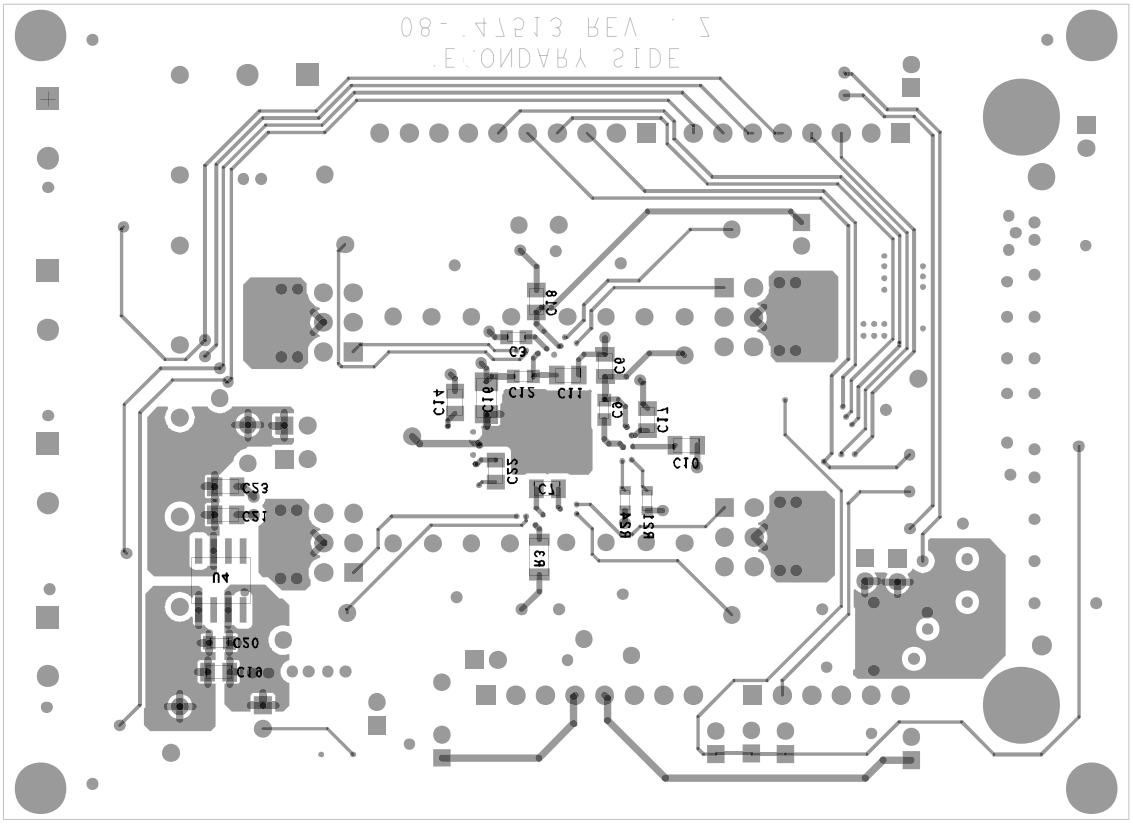

Figure 17. Layer 4, Bottom Layer

ORDERING INFORMATION

BILL OF MATERIALS

Table 3.

Qty	Reference Designator	Description	Manufacturer	Part Number
30	5V_BOARD, ADR_REF, AGND1, AGND2, AGND_SENSE, ALDO1V8, ALDO5V, AVDD, AVSS, DLDO1V8, DVCC, I/ON_A, I/ON_B, I/ON_C, I/ON_D, I/OP_A, I/OP_B, I/OP_C, I/OP_D, IOVDD, REFIN, REFOUT, SENSEHF_A, SENSEHF_B, SENSEHF_C, SENSEHF_D, SENSELF_A, SENSELF_B, SENSELF_C, SENSELF_D	Red test points	Vero Technologies	20-313137
5	AVDD_SUPPLY, CH_A, CH_B, CH_C, CH_D	Printed circuit board (PCB) connectors, 2-position header	Phoenix Contact	1759017
1	C1	10 µF capacitor	TDK	C5750X7S2A106M230KB
7	C7, C10, C14, C17, C18, C22, C25	0.1 µF capacitors	AVX Corporation	08055C104K4T4A
2	C6, C11	2.2 µF capacitors	YAGEO	CC0805KKX7R6BB225
4	C3, C9, C12, C20	0.1 µF capacitors	Dielectric Labs	P62BN820MA2636
2	C8, C13	10 µF capacitors	Murata	GRM21BR61C106KE15L
1	C15	10 µF capacitor	Murata	GRM32ER71H106KA12L
3	C2, C4, C16	10 µF capacitors	Samsung	CL31B106KBHNNNE
3	C19, C21, C23	1 µF capacitors	Murata	GCM21BR71E105KA56L
1	C24	0.33 µF capacitor	AVX	0603YD334KAT2A
9	C5, C26, C27, C28, C29, C32, C33, C34, C35	0.01 µF capacitors	Murata	GRM2195C1H103JA01D
4	C30, C31, C36, C37	0.068 µF capacitors	TDK	C3216C0G1H683J
4	C38, C39, C40, C41	0.001 µF capacitors	Panasonic	ECH-U1H102JX5
4	CR1, CR2, CR3, CR4	Screw terminal isolation diodes	ON Semiconductor	BAV99WT1G
4	D1, D2, D3, D4	Transient voltage suppressors (TVSs)	ST Microelectronics	SMCJ40CA-TR
4	DS1, DS2, DS3, DS4	Red light emitting diodes (LEDs)	VISHAY	VLMS30J1L2-GS08
15	JP1, JP2, JP3, JP4, JP5, JP6, JP7, JP8, JP9, JP10, JP11, JP12, JP13, JP14, JP15	2-pin jumpers	HARWIN	M22-2010205
1	L1	100 µH inductor	Wurth Elektronik Group	744043101
1	P1	120-pin connector	HRS	FX8-120S-SV(21)
4	P6, P7, P12, P13	6-pin jumpers	SAMTEC	TSW-103-08-G-D
2	P14, P17	8-pin connectors	SAMTEC	SSQ-108-03-G-S
1	P15	6-pin connector	SAMTEC	SSQ-106-03-G-S
1	P16	10-pin connector	SAMTEC	SSQ-110-03-G-S
4	Q1, Q2, Q3, Q4	Power metal-oxide semiconductor field effect transistors (MOSFETs)	Fairchild Semiconductor	FDC5614P
1	R1	0 Ω resistor	Panasonic	ERJ-6GEY0R00V
12	R4, R5, R6, R7, R9, R10, R11, R12, R13, R14, R15, R16	0 Ω resistors	Multicomp (SPC)	MC0603WG00000T5E-TC
3	R8, R18, R19	100 kΩ resistors	Multicomp (SPC)	MC 0.063W 0603 1% 100K
1	R2	22 mΩ resistor	Stackpole Electronics, INC.	RMCF 1/10 22M 5% R
2	R21, R24	10 kΩ resistors	Panasonic	ERJ-3EKF1002V
4	R22, R23, R25, R26	1 kΩ resistors	Panasonic	ERJ-3EKF1001V
4	R27, R31, R37, R41	2 kΩ resistors	TE Connectivity	RN73C2A2K0BTG
8	R28, R30, R32, R34, R38, R40, R42, R44	10 kΩ resistors	Panasonic	ERJ-6ENF1002V
4	R29, R33, R39, R43	2 kΩ resistors	Panasonic	ERJ-6ENF2001V
1	R3	0 Ω resistor	Panasonic	ERJ-8GEY0R00V
4	R35, R36, R45, R46	100 Ω resistors	YAGEO	RT0805BRB07100RL
1	S1	Switch	OMRON	B3U-1000P

Qty	Reference Designator	Description	Manufacturer	Part Number
1	U1	Software configurable input/output	Analog Devices	AD74412RBCPZ
1	U2	3.3 V Regulator	Analog Devices	ADP1720ARMZ-3.3-R7
1	U3	Buck regulator	Analog Devices	ADP2360ACPZ-5.0-R7
1	U4	External reference	Analog Devices	ADR4525BRZ
1	U5	I²C serial electrically erasable programmable read-only memory (EEPROM)	Microchip Technology	24LC32A/SN
5	Not applicable	Terminal plug	Phoenix Contact	1757019

I²C refers to a communications protocol originally developed by Philips Semiconductors (now NXP Semiconductors).

ESD Caution
ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

UG21413-0-9/19(0)